Lecture Module - Steady State Circuits

Mechanical Engineering

Tennessee Technological University

Topic 2 - Fundamental Laws

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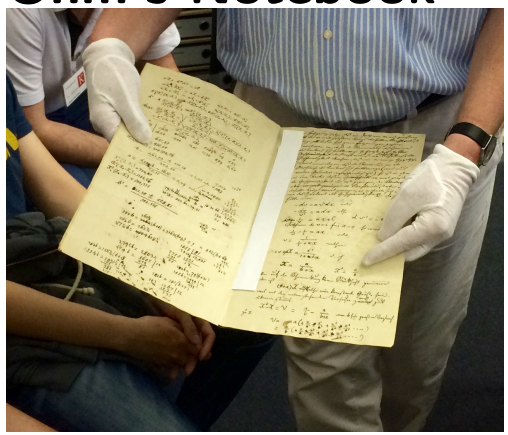
- Ohm's Law
- Combining Resistance
- Kirchhoff's Laws
- Power Dissipation

Ohm's Law

James Maxwell

George Ohm

Ohm's Notebook

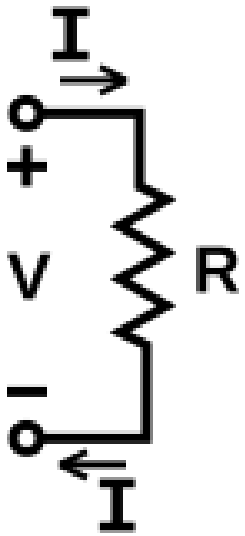


Ohm did his work on resistance in the years 1825 and 1826, and published his results in 1827 as the book Die galvanische Kette, mathematisch bearbeitet...

Ohm's Law

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points.

$$I = \frac{V}{R}$$

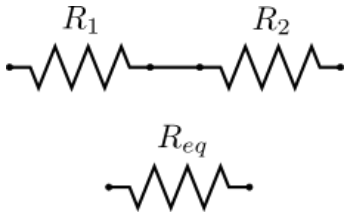


It is more commonly shown in the following form.

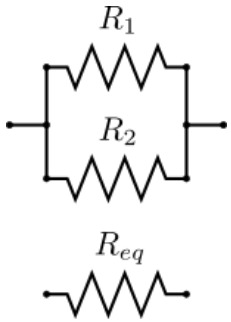
$$V = IR$$

Combining Resistance

Resistors in Series



$$R_{eq} = R_1 + R_2$$



$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

Resistors in Parallel

Kirchhoff's Laws

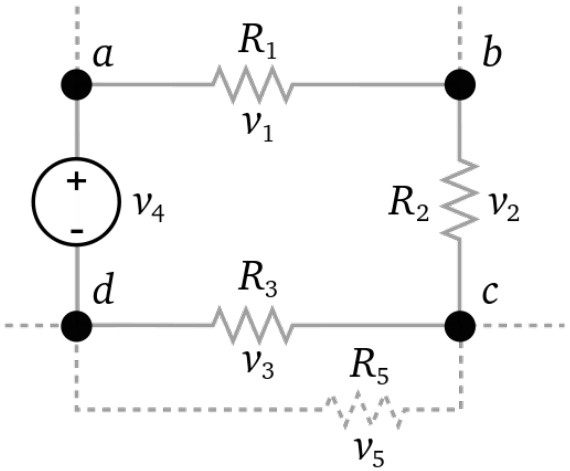
Both of Kirchhoff's laws can be understood as corollaries of Maxwell's equations in the low-frequency limit. They are accurate for DC circuits, and for AC circuits at frequencies where the wavelengths of electromagnetic radiation are very large compared to the circuits.

1. Kichhoff's Voltage Law (KVL)
2. Kichhoff's Current Law (KCL)

Kirchhoff's Laws

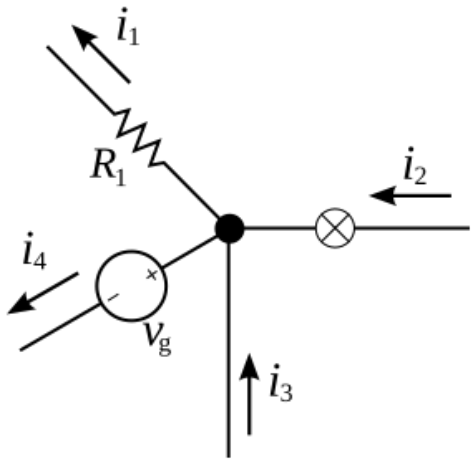
Kichhoff's Voltage Law (KVL) - The sum of the voltages around a loop (aka mesh) equals zero.

$$\sum_{k=1}^{n} v_k = 0$$



Kichhoff's Current Law (KCL) - The sum of the current flowing in and out of node (aka junction) equals zero.

$$\sum_{k=1}^{n} i_k = 0$$



Power Dissipation

Energy is transformed in to heat in passive circuit components. For a resistor the power dissipation can be found with following relations.

$P = IV$ $V = IR$

Power Dissipation

Power is the rate of energy dissipated, aka the amount of energy lost per unit of time. How do we compute total energy for the power?

$$E = \int_{t1}^{t2} P dt$$